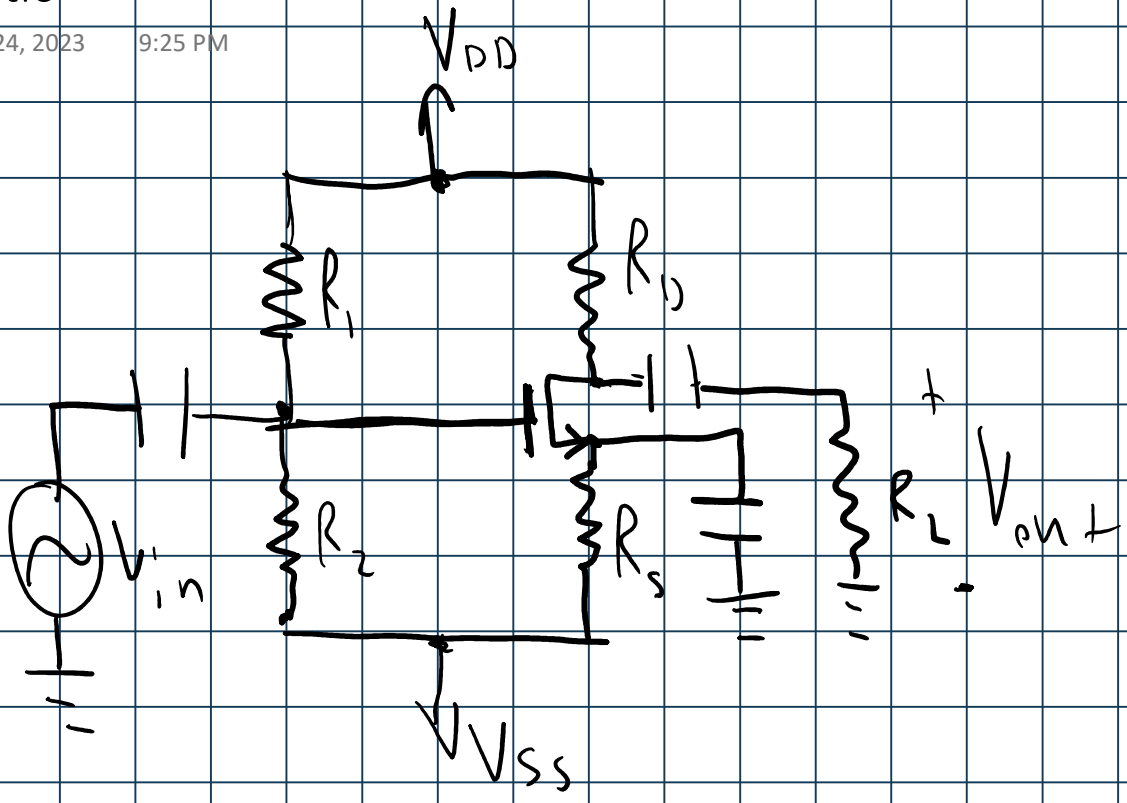
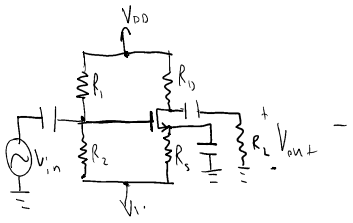
Schematic

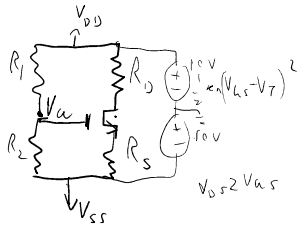
Monday, April 24, 2023 9:25 PM



DC Analysis

Tuesday, April 25, 2023 3:45 PM





$$V_G = V_{DD} - (V_{DD} - V_{SS}) \frac{R_1}{R_1 + R_2}$$

$$V_G = -0.526\ V$$

$$V_{GS} = V_G - V_S, \quad V_{GS} = V_G - (V_{SS} + I_D R_S)$$

$$I_D = k_2 (V_G - V_{SS} - I_D R_S - V_T)^2$$

$$I_D = k_2 ((V_G - V_{SS} - V_T) - I_D R_S)^2$$

$$x = (V_G - V_{SS} - V_T)$$

$$I_D = \frac{1}{2} k (x - I_D R_S)^2$$

$$I_D = \frac{1}{2} k (x^2 - 2x R_S I_D + R_S^2 I_D^2)$$

$$I_D = \frac{1}{2} k x^2 - k x R_S I_D + \frac{1}{2} k R_S^2 I_D^2$$

$$0 = \frac{1}{2} k x^2 + (-k x R_S - 1) I_D + \frac{1}{2} k R_S^2 I_D^2$$

Roots: $I_D = 701\ \mu A,\ 6778\ \mu A$

$$V_{GS} = V_G - (V_{SS} + I_D R_S)$$

For $I_D = 70\,\mu A$,

$V_{GS} = 2.113V$, $V_{GS} < V_T \therefore I_D \neq 70\,\mu A$

For $I_D = 677.8\,\mu A$,

$\boxed{V_{GS} = 2.357V}$, $V_{GS} > V_T \therefore \boxed{I_D = 678\,\mu A}$

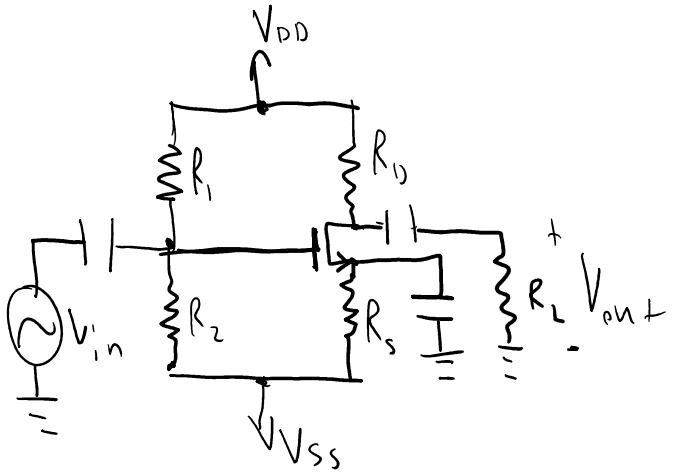
$$V_{DD} - I_D R_D - V_{DS} - I_D R_S = V_{SS}$$

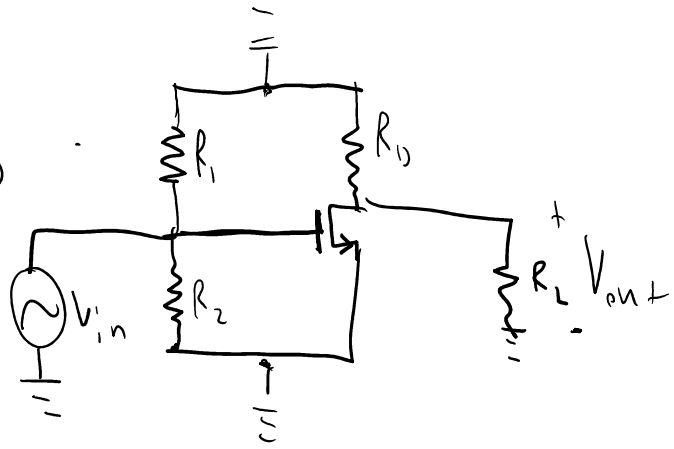
$$V_{DD} - I_D R_D - I_D R_S - V_{SS} = V_{DS}$$

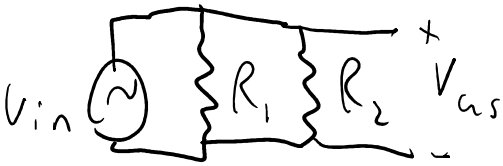
$$\boxed{V_{DS} = 6.783\,V}$$

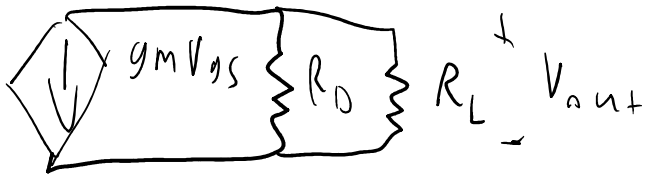
AC Analysis

Tuesday, April 25, 2023 4:45 PM









$V_{gs} = V_{in}$ $g_m = \frac{2I_D}{V_{OV}} = .0112$

$V_{out} = -g_m V_{in} \cdot R_D \| R_L$

$Gain = \frac{V_{out}}{V_{in}} = -g_m R_D \| R_L$

$r_{in} = R_1 \| R_2 = \frac{R_1 R_2}{R_1 + R_2} = 7.105\,k\Omega$ (r_{in})

$r_{out} = R_D \| R_L = 6.207\,k\Omega$ (r_{out})

$Gain = -69.774 \frac{V}{V}$